PATENT SPECIFICATION

DRAWINGS ATTACHED

997,118

997,118

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COMPLETE SPECIFICATION

A Gas Turbine Plant

We, BROWN, BOVERI & COMPANY LIMITED, a Swiss Company, of Baden, Switzerland., do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a gas turbine plant, and in particular to a gas turbine plant in which the ouput of the plant is increased by introducing an additional fluid into the gas-turbine working fluid.

There are various ways of making use of the exhaust-gas heat of a gas turbine. Thus, it is customary in many cases to place an air-pre-heater after the gas turbine in order further to heat the combustion air emanating from the compressor. The heat recovered is returned to the gas-turbine working fluid in this way. In large plants, there is often a steam boiler, which is supplied with exhaust gases from the gas turbine, and serves to feed a steam turbine. This enables the efficiency of the whole plant to be considerably increased. Occasionally, a non-regenerative boiler is placed after a gas turbine, and the steam so obtained is fed to the hot combustion gases in order to increase the output. Experience shows that the increase in output amounts to about 5% if 1% steam is admixed with 100% air. Other proposals for profiting by the exhaust-gas heat are known, as also are combinations of the possibilities named.

Generating steam from the exhaust-gas heat of a gas turbine yields a considerable increase in output, as mentioned above, but has the one disadvantage of requiring feed water which is purified or can easily be treated. Now it often happens, for example in power stations in tropical regions, that crude liquids of some kind, unsuitable for boiler-feed purposes, are present, but on the other hand that no useable water capable of being purified with relatively simple means is available.

It is an object of the present invention to reduce substantially or eliminate these difficulties.

According to the invention there is provided a gas turbine plant including distilling means for providing a distillate from a crude liquid, means for vapourising the distillate, means for feeding the distillate directly to the vapourising means, and means for feeding the vapourised distillate to the working fluid of the plant at a point before the turbine stage of the plant, the arrangement being such that both the distilling means and the vapourising means heat the crude liquid and distillate respectively by means of exhaust gas from the turbine stage.

Features and advantages of the invention will be apparent from the following description of embodiments thereof, given, by way of example, in conjunction with the accompanying drawings, the same reference numbers being allotted to the same parts in both Figures.

In Figure 1, the gas-turbine plant consists of the air-compressor 1, the combustion chamber 2 to which the fuel is fed at 3, and the gas turbine 4. The exhaust gases of the turbine give up some of their heat in a heat-exchanger 5 before emerging into the atmosphere at 6.

The gas turbine is followed by a distillation plant in which a distillate is obtained from a crude liquid by making use of exhaust-gas heat from the turbine. The crude liquid delivered by a pump 7 is heated by the exhaust gases of the turbine in the heater 8, and then expanded by the reducing valve 9 before flowing into the evaporator 10. Some of the superheated crude liquid now evaporates here, while the remainder runs away through the conduit 11.

The evaporated portion of the crude liquid

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is precipitated in a condenser. It is advantageous to use for this purpose a condenser 12 in which the crude liquid itself is used as the coolant. As a result, the crude liquid heats up, and enters the heater 8 at increased temperature, which means that better use is being made of the exhaust-gas heat.

The distillate is delivered by a condensate pump 13 to the vaporiser 14, where it vaporises again, and is fed in the form of an additional fluid to the gas-turbine working fluid. This can be done in the air path after the compressor or directly before the gas turbine, but it is most expedient to introduce the vaporised distillate directly into the combustion chamber. This gives reliable mixing with the combustion gases without the need for further auxiliary means.

It is advantageous to combine the heater 8 and the vaporiser 14 to form one structural unit, since such a heat exchanger 5, which may be built up after the manner of a boiler, takes up less space and reduces heat losses.

The yield of distillate may be affected by putting the heat-exchange surface in the condenser into or out of action, or by changing the quantity flowing through it. The plant may be subdivided into individual evaporator-and-condenser groups in order to give optimum production from the thermal standpoint, with the result that maximum recovery of heat can be attained from the distillate in course of condensation.

It can occasionally happen that the hot residual liquid cannot be further used, nor can it be returned to its source, which may be a canal or river, on account of its high temperature. In this case, an appropriate solution is to mix the residual quantity with fresh crude liquid tapped off after the pump 7 or after the condenser 12 via the adjustable conduit 15.

If the temperature of the crude liquid as it enters the heater is below the dew point of the exhaust gases, a condensate will be precipitated on the pipes of the heater, which may lead to corrosion. This can be countered by a communicating conduit 16 from the output to the input side of the heater. As a result, some of the crude liquid is placed in circulation, so that the minimum temperature level in the heater is raised. The circulating pump 17 need only make up the flow losses in the heater, but a somewhat larger heat-exchange surface is necessary.

The plant in Figure 2 shows another possible way of avoiding corrosion in the pipes. The plant as a whole is constructed in a similar manner to that in Figure 1, but the crude liquid is now heated by an intermediate medium. As a result of this arrangement, the heater 18 no longer comes into contact with the exhaust gases of the turbine. The distillate itself is advantageously used as the intermediate medium, being taken from the vaporiser 19 when ony slightly heated and still in the liquid state, passed via the conduit 20 to the heater 18, and after giving up its heat being placed in circulation with the distillate to the vaporiser 19. Thus some of the distillate is circulated, with the result that the minimum temperature level in the vaporiser is raised. The pump 21 then acts both as a feed and circulating pump. The remainder of the distillate is vaporised and conveyed to the combustion chamber. A regulator valve 22 is provided, in order to adjust the amount conveyed to the combustion chamber.

The plants shown in Figures 1 and 2 enable crude liquid of any kind to be used. The latter may be industrial waste water, dirty water or sea water, and in deserts effective use may be made of salt lakes; in principle, any crude liquid whereof the vapours do not attack the structural parts and are not poisonous may be used. The distillation yields a pure product which may be introduced into the gas-turbine working fluid, without causing any contamination or corrosion. If crude water is present, it is also possible by distilling out larger quantities to use the plant for obtaining drinking water, which is an advantage not to be underestimated, especially in regions where water is scarce.

WHAT WE CLAIM IS:—

1. A gas turbine plant including distilling means for providing a distillate from a crude liquid, means for vapourising the distillate, means for feeding the distillate directly to the vapourising means, and means for feeding the vapourised distillate to the working fluid of the plant at a point before the turbine stage of the plant, the arrangement being such that both the distilling means and the vapourising means heat the crude liquid and distillate respectively by means of exhaust gas from the turbine stage.

2. A gas turbine plant according to claim 1, in which the distilling means is arranged so that the crude liquid is used to condense the distillate.

3. A gas turbine plant according to claim 1 or claim 2, in which the feeding means is arranged so that the vapourised distillate is introduced into the combustion chamber.

4. A gas turbine plant according to any one of claims 1 to 3, in which the distilling means is arranged so that the crude liquid is heated by an intermediate medium.

5. A gas turbine plant according to claim 4, in which the distillate is used as the intermediate medium.

6. A gas turbine plant according to any one of the preceding claims, in which the heater section of both the distilling means and the vapourising means are combined to form one structural unit.

7. A gas turbine plant according to claim 5 or claim 6 as appendant to claim 5, in which the vapourising means is arranged so that the intermediate medium is taken from the vapourising means when partly heated, and after giving up its heat to the crude liquid is returned to circulation with the distillate to the vapourising means.

8. A gas turbine plant according to any one of the preceding claims, and including a source of crude water for said distilling means.

9. A gas turbine plant according to claim 8, in which said crude water is salt water.

10. A gas turbine plant substantially as herein described with reference to and as illustrated in Figure 1 or Figure 2 of the accompanying drawings.

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997118 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1.

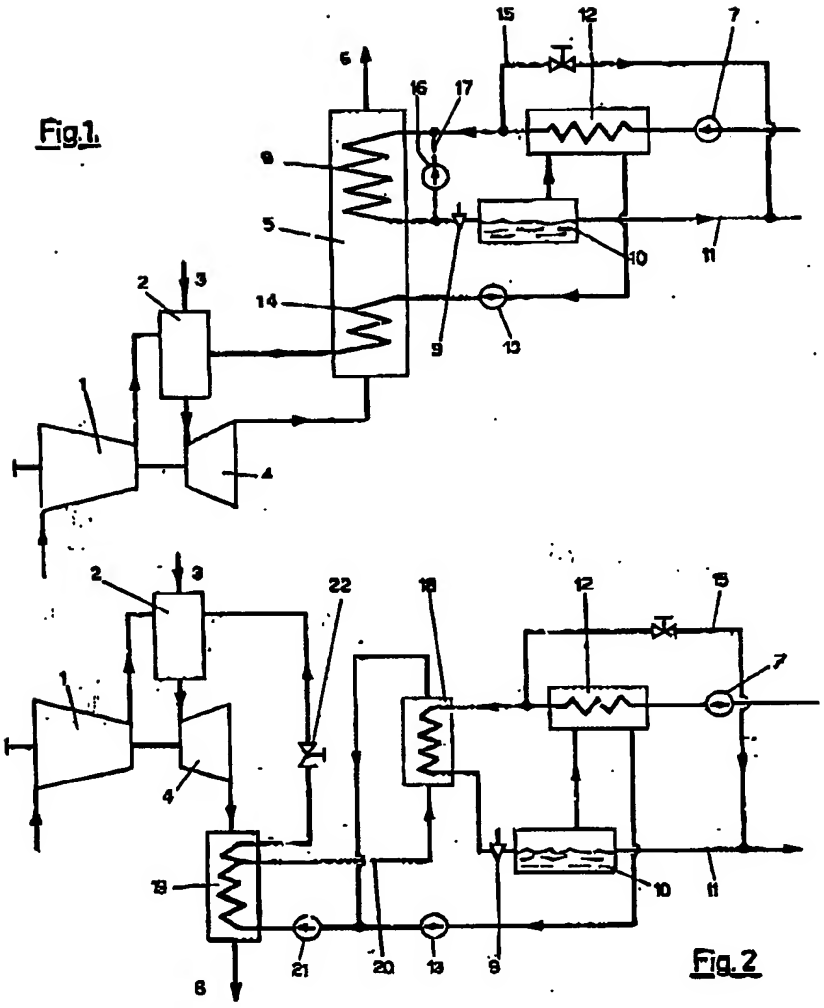

Fig.2

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/US2004/028803

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:
see 'Invitation to pay additional fees'
2. This communication is not the international search report which will be established according to Article 18 and Rule 43.
3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.
4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 997 118 A (BROWN, BOVERI & COMPANY LIMITED) 30 June 1965 (1965-06-30) page 1, line 70 - page 2, line 18; figures 1,2 page 2, line 34 - line 38 page 2, line 57 - line 85	1,2,4, 10-14, 17, 31-33, 36,37, 50,51
A	US 4 623 528 A (BARBER ET AL) 18 November 1986 (1986-11-18) column 3, line 27 - line 49	1,11,31, 36
X	US 4 485 077 A (MARTINEZ ET AL) 27 November 1984 (1984-11-27)	36
A	column 5, line 33 - line 36; figure 1	1,11,31

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Patent Family Annex

Information on patent family members

International Application No
PCT/US2004/028803

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 997118	A	30-06-1965	CH	398181 A	31-08-1965
			BE	637344 A	
			NL	297860 A	
US 4623528	A	18-11-1986	NONE		
US 4485077	A	27-11-1984	NONE		